On the proposed Expedition to observe the approaching Opposition of Mars. By Mr. David Gill.

The approaching opposition of *Mars* is the most favourable of the century for determining the Solar Parallax, the horizontal parallax at opposition being within 5 per cent. of the difference of the horizontal parallax of the Sun and *Venus* at the Transit of 1874.

During six weeks observations can be made in conditions of temperature and of freedom from hurry or excitement infinitely more favourable to good observations than those afforded by the Transit of *Venus*. By observing the diurnal parallax, the same observer gets a result which is entirely free from errors of personality, and he also obtains a factor of parallax larger than can be obtained by any two existing observatories.

So early as 1857 the Astronomer Royal called attention to the present opposition, and then expressed his opinion—an opinion to which he still adheres—that observations of the diurnal parallax of the planet at such an opposition present the best means of determining the Solar Parallax.

The method proposed by the Astronomer Royal was to observe the difference of R.A. of the planet and stars in the evening and morning, and by such a method, with a proper equatoreal and a skilful observer, there is no doubt that results of very high accuracy could be attained. The success which has attended the observations of *Juno* (the results of which are communicated to the Society to-night) led me to believe that the original plan of the Astronomer Royal might be somewhat modified, and the heliometer successfully substituted for the ordinary equatoreal, according to a plan of observation afterwards described.

I applied in the first place to Lord Lindsay, who, in the kindest manner and with the most complete sympathy with the purposes in view, at once placed the instrument at my disposal.

I then submitted detailed plans of the proposed observations to the Astronomer Royal, to the Council of this Society, to Prof. Adams, and to Dr. Robinson and Mr. Hind, and I gratefully acknowledge the support in the matter which I have received at their hands, as also the promises of substantial assistance, should it be required, which I have received from Sir George Airy, Mr. De La Rue, Mr. Proctor, and others. I have also consulted Dr. Auwers of Berlin as to several details of these plans, and have now, as at all times, received from him the kindest and most valuable assistance. I now beg to present to the Society the following plan of the proposed observations:—

Selection of Place of Observation.

In heliometer observations distances are measured with much greater accuracy than position-angles; therefore we should endeavour to select stars nearly vertically above or below the

planet if we wish to have the full amount of parallactic displacement most advantageously measured. The star which is vertically above or below the planet in the evening observations (neglecting the planet's motion) can only be vertically above or below the planet in the morning in one case, and that is when the observer's station is on the equator and the star's and planet's declination are both 0°.

When the planet has any other declination, we must endeavour to select a station in which the planet is on the prime vertical at the mean altitude of observation (found practically to be 30°), and to select the stars of comparison of the same declination with the planet. The observations evening and morning are then symmetrically disposed as to parallactic displacement. In the case of *Mars* at the present opposition this condition is realised in a latitude about 8° S.

The meteorological conditions are also, of course, all-important, and it has been suggested to me that I should occupy some rainless district in the highlands of Peru, affording almost the certainty of clear weather every night. There appears to be a very serious drawback, however, in the great difference of temperature between day and night. It is no uncommon thing, in the higher districts there, to have a temperature verging on 100° Fahr. by day and freezing by night, and I feared, however perfectly and symmetrically the comparison stars and observations may be arranged for the elimination of progressive change of scale-value, that errors due to temperature may yet creep in which might have a systematic character.

In this respect insular stations have a great advantage, and after much consideration I have selected the Island of Ascension—originally suggested to me by Lieut. Neate, R.N.—as the most suitable site. Its geographical position is almost absolutely the best possible, and to Mr. Scott and Captain Toynbee I am indebted for a copy of a work, just issued by the Meteorological Office, on the meteorology of this island.

The proportion of cloud is from 5·0 to 6·0 (10 being total obscuration) for the date and hours of observation, a proportion smaller than Mauritius, where the conditions were sufficiently favourable. Two or three degrees appear to be the range of temperature between 6 P.M. and 6 A.M.

Selection of Stars of Comparison.

In making this selection, a complete list was independently prepared of all the stars of 8th magnitude or brighter near the path of *Mars* contained in the following catalogues:—

Catalogue of the Berlin Academy Star Maps.
Weisse's Bessel.
Lalande.
Santini.
Lacaille.

These were all independently reduced to 1877·0 and plotted on a chart, together with the path of the planet. It proved that several very important stars were omitted in Bessel's Catalogue; the reason, I believe, being, that when that Astronomer found two stars in the field and could not observe both, he always chose the fainter star, leaving the larger star to other observers, as less likely to be overlooked by them.

Such an omission is the star marked *g* ($7\frac{1}{2}$ mag.) in the catalogue, which is very important, because on September 5 the planet approaches within 2′ of this star.

In the selection of the stars of comparison, I have been guided by the following considerations:—

1. It is desirable, if possible, and if consistent with the main end in view—the parallax determination—to make the most accurate determination possible of the absolute place of the planet for the purposes of gravitational astronomy.
2. Position-angle measures being greatly inferior to measures of distance in point of accuracy, the determination of absolute positions will be best secured by relying on the distance measures only.
3. The minimum number of stars by which an absolute place can be secured by distance measures is three, and it is not desirable to measure more, because to measure from three stars symmetrically will require nearly all the time which the measures should occupy.
4. The planet *must* be contained within the triangle formed by the three stars of comparison; and, since the change in R.A. is the most important, two of the stars should be about the same declination with the planet, and as nearly as possible equally distant from it. When this is not possible, the stars must be arranged to determine rigidly the displacement in R.A., sacrificing, if necessary, the declination.
5. When stars can be found sufficiently bright, and nearly of the same declination with the planet, not more than 2000″ or 3000″ apart, then the method of two stars, employing position-angles, is best if the planet is nearly in the line joining the stars of comparison.

In the equations of condition which result from measures of distance with stars so selected, it is always possible to consider the error of the scale-value an unknown quantity, and to determine it from the stars of comparison in each group of observations. This is the best method for complete elimination of systematic error when the places of the stars of comparison are determined with tolerable precision.

To secure such precision, as well for this purpose as for the determination of the absolute place of the planet, the places of the stars of comparison must be determined by meridian observations; and to increase the precision of the result, the whole of

the stars should be connected by a heliometric triangulation. To effect this it has been necessary to introduce a few additional stars, in general denoted by Greek letters.

I have also included in the list the star ψ^1 *Aquarii*, because peculiar interest attaches to it from the fact that it was occulted by *Mars* in 1672, October 1. The occultation was observed by Richer at Cayenne, by Picard near Beauford, and by Roemer at Paris, and the observations are in very close accordance (Le Verrier, *Comptes Rendus*, 1872, July 22). In this paper, M. Le Verrier deduces the Earth's mass, and thence the solar parallax, from the secular variation of the planet's longitude produced in two centuries by the action of the Earth, employing the occultation just cited with Bradly's observations of the star, on the one hand, and modern meridian determinations on the other.

The present opportunity for making a rigid determination of the planet's heliocentric place is infinitely more favourable than that of 1672, because the determination can be made to depend upon so many stars. There is no doubt that, if many observations of the stars of comparison and of fundamental stars are made at different observatories and with different meridian circles, and the heliometer observations have even moderate success, a determination of the heliocentric place of the planet will be secured of far higher accuracy than any hitherto obtained.

I therefore most earnestly solicit the co-operation of observatories possessing good meridian instruments in this work, and shall gratefully acknowledge and utilise any such observations communicated to me, addressed to the Rooms of the Society.

Mr. Hartnup, at Liverpool, has most kindly volunteered to apply the splendidly rigid Equatoreal of his Observatory to the determination of the differences of R.A. and declination of these stars of comparison. These observations will chiefly strengthen the heliometric triangulation, but do not supersede the desirability, or even necessity, for good meridian observations also.

Stars to be observed with Mars at Opposition 1877.

Adopted Name of Star.	Approximate. 1877·0 R.A. h m s	Dec. ° ′	No. in Weisse's Bessel.	Mag.	Mag. in Berlin Academy Star Cat.	No. in Lalande.	Mag.	No. in Santini.	Mag.	Remarks.
a	22 47 0	−12 16	xxii. 956	7	6	44756	6	2577 (1858)	7	
b	22 47 38	−12 50	966	7–8	7–8	...	8	2140 (1862)	7–8	
a	22 51 37	−11 47	1047	9						
c	22 53 7	−13 44	1079	6	7	44937	6½	2145 (1862)	6–7	
β	22 56 4	−11 55	1156	8	8	45050	8	2591 (1858)	8–9	Lalande has Dec. −10° 55′.
μ	22 58 3	−12 50	1204	8	8	...	...	2154 (1862)	8	Schj. $22^h\ 58^m\ 2^s{\cdot}91$ −12° 50′ 26″·8 (8–7)
d	22 59 28	−11 6	1232	8	7–8	45169	7	2594 (1858)	8	
γ	23 0 30	−13 23	1249	8	8–9	45197	9			
e	23 0 58	−12 28	1261	8	8	45213	8	2599 (1858)	7–8	
δ	23 5 3	−11 10	xxiii. 49	9						
ϵ	23 5 32	−12 36	57	8	8	45380	7			
f	23 8 16	−11 21	123	7	7	45490	6			
g	23 8 55	−12 14	...	...	7–8	45504	7½			
ψ^1 Aq.	23 9 27	− 9 45	...	4–5						

h	23 11 15	−12 23	xxiii. 185	7	7	45582	6	2618 (1858)	7	
i	23 12 34	−10 17	226	5–6	5	45628	6	2622 (1858)	5–6	ψ^3 Aquarii.
k	23 12 37	−12 51	228	8	8	45633	7	2177 (1862)	7	
l	23 14 29	−11 12	265	8	8	45708	8	2625 (1858)	8	
λ	23 16 36	−11 27	309	8	8–9	45777	8	2627 (1858)	8	
ζ	23 16 55	−10 4	315	8	8	45789	8	...	...	Schj. $23^h\ 16^m\ 54^s{\cdot}26$ $-10°\ 3'\ 33''{\cdot}1$ (8–7)
η	23 20 14	−10 43	377	9						
m	23 21 40	−12 7	402	7	7	45937	6	2634 (1858)	7	
n	23 22 39	− 9 57	427	7	7	45965	6½	2636 (1858)	7	
q	23 26 4	−11 41	497	7	7	46090	6½	2643 (1858)	7	
r	23 29 6	−11 14	571	8	8	...	...	2653 (1858)	8	
s	23 29 40	− 9 27	586	7–8	7–8	46229	7½	...	...	Schj. $23^h\ 29^m\ 39^s{\cdot}37$ $-9°\ 26'\ 40''{\cdot}7$ (8)
	23 31 52	− 9 19	629	7	7	46296	7½			

B B

Plan of Heliometric Triangulation of Stars to be compared with Mars.

Stars.	Mag.	R.A. h m s	Dec. ° ′	Position Angle. °	Distance. ′
a—*b*	6-7—7-8	22 47 19	−12 33	344·9	35
a—α	6-7—9	49 19	12 2	246·8	74
b—α	7-8—9	49 37	12 19	222·9	86
b—*c*	7-8—6-7	50 22	13 17	303·9	97
c—α	6-7—9	52 22	12 46	164·1	119
c—β	6-7—8	54 37	12 50	201·6	117
c—γ	6-7—8	56 47	13 34	259·0	110
α—β	9—8	53 51	11 51	277·0	66
β—*d*	8—7-8	57 46	11 31	225·6	70
β—*e*	8—8	58 31	12 12	294·7	79
β—γ	8—8	22 58 17	12 39	323·6	109
d—δ	7-8—9	23 2 16	11 8	272·8	82
d—*e*	7-8—8	0 13	11 47	344·9	85
γ—*e*	8—8	0 44	12 56	187·1	55
γ—ε	8—8	3 1	13 0	237·4	87
e—δ	8—9	3 1	11 49	217·6	98
e—ε	8—8	3 15	12 32	276·8	67
δ—ψ¹ Aq.	9—4-5	7 15	10 28	217·4	107
δ—*f*	9—6-7	6 40	11 16	283·1	49
δ—*g*	9—7-8	6 59	11 42	318·4	86
δ—*h*	9—6-7	8 9	11 47	308·7	117
δ—ε	9—8	5 18	11 53	355·3	86
ε—*f*	8—6-7	6 54	11 59	208·1	85
ε—*g*	8—7-8	7 14	12 25	246·1	54
ε—*h*	8—7	8 24	12 30	261·2	85
ε—*k*	8—7-8	9 5	12 44	278·2	105
f—ψ¹ Aq.	6-7—4-5	8 52	10 33	190·3	98
f—*g*	6-7—7-8	8 36	11 48	349·7	54
f—*h*	6-7—7	9 46	11 52	324·7	76
f—*i*	6-7—5-6	10 25	10 49	224·8	90
f—*l*	6-7—8	11 23	11 17	264·4	92
f—*k*	6-7—7-8	10 27	12 6	324.7	110
g—*e*	7-8—8	4 57	12 21	83·2	117
g—*h*	7-8—7	10 5	12 19	284·8	35
g—*k*	7-8—7-8	10 46	12 33	304·4	66
g—*l*	7-8—8	11 42	11 43	232·9	103
ψ¹ Aq.—ζ	4-5—8	13 11	9 55	279·8	112

Stars.	Mag.	R.A. h m s	Dec. ° ′	Position Angle. °	Distance. ′
ψ^1 Aq.—i	4-5—5-6	23 11 1	−10 1	304·7	56
ψ^1 Aq.—l	4-5—8	11 58	10 29	319·5	114
h—l	6-7—8	12 52	11 48	213·8	85
h—k	6-7—7-8	11 56	12 37	324·5	34
i—ζ	5-6—8	14 45	10 11	258·6	66
i—l	5-6—8	13 32	10 45	332·8	62
k—l	7-8—8	13 33	12 2	195·5	103
l—ζ	8—8	15 42	10 38	207·8	77
l—η	8—9	17 22	10 58	251·1	90
l—m	8—6-7	18 5	11 40	297·5	119
ζ—n	8—6-7	19 47	10 1	265·3	85
ζ—η	8—9	18 35	10 24	308·5	63
η—q	9—7	23 9	11 12	304·4	104
η—m	9—6-7	20 57	11 25	345·9	87
η—n	9—6-7	21 27	10 20	217·8	58
m—q	6-7—7	23 52	11 54	248·1	70
n—q	6-7—7	24 22	10 49	334·2	116
n—r	6-7—8	25 56	10 36	309·0	122
n—s	6-7—7-8	26 10	9 42	253·9	108
q—r	7—8	27 35	11 28	238·8	52
r—s	8—7-8	29 23	10 21	184·5	107
s—t	7-8—7	30 46	9 23	256·2	33
λ—h	8—6-7	13 56	11 55	54·4	96
λ—i	8—5-6	14 35	10 52	139·6	92
λ—k	8—7-8	14 37	12 9	34·9	102
λ—l	8—8	15 33	11 20	115·5	35
λ—m	8—6-7	19 8	11 47	298·2	85
λ—η	8—9	18 25	11 5	230·5	69
λ—ζ	8—9	23 16 46	10 46	183·3	83
μ—α	8—9	22 54 49	12 19	123·9	113
μ—β	8—8	57 3	12 23	152·5	62
μ—c	8—6-7	55 34	13 17	52·8	89
μ—γ	8—8	59 16	13 7	312·2	49
μ—d	8—7-8	58 45	11 58	191·6	106
μ—e	8—8	22 59 30	12 39	243·0	48
μ—ϵ	8—8	23 1 47	12 43	262·8	111

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Plan of Observation of Mars and Comparison Stars.

[P denotes the planet; other letters the stars in the preceding list.]

Day. 1877.	Stars of Comparison.	Mag.	Hour Angle -4^h (Evening Observations). R.A. of Middle Point.	Dec. of Middle Point.	Position Angle.	Distance.	Hour Angle $+4^h$ (Morning Observations). R.A. of Middle Point.	Dec. of Middle Point.	Position Angle.	Distance.
			h m s	° ′	°	′	h m s	° ′	°	′
Aug. 1	P—*q*	7–8	23 26 58	−10 44	13·0	117	23 27 1	−10 44	13·8	116
	P—*n*	7	25 15	9 52	82·6	77	25 18	9 52	83·5	79
	P—*t*	7	29 52	9 33	244·8	66	29 55	9 33	243·4	65
2	P—*q*	7–8	27 5	10 45	15·0	116	27 8	10 45	15·7	116
	P—*n*	7	25 22	9 53	84·3	81	25 25	9 53	84·4	82
	P—*t*	7	29 59	9 34	241·7	63	30 2	9 34	241·0	62
3	P—*q*	7–8	27 12	10 46	16·7	116	27 13	10 46	17·0	115
	P—*n*	7	25 29	9 54	85·2	84	25 30	9 54	85·9	84
	P—*t*	7	30 6	9 35	239·5	61	30 7	9 35	238·4	61
4	P—*q*	7–8	27 16	10 47	17·9	114	27 17	10 47	18·3	114
	P—*n*	7	25 33	9 55	86·7	87	25 34	9 55	87·4	88
	P—*t*	7	30 10	9 36	236·9	60	30 11	9 36	235·7	60
5	P—*q*	7–8	27 19	10 48	18·9	113	27 19	10 48	19·2	112
	P—*n*	7	25 36	9 56	88·0	88	25 36	9 56	88·7	88
	P—*t*	7	30 11	9 37	234·5	60	30 11	9 37	233·6	61
6	P—*q*	7–8	27 20	10 49	19·6	111	27 20	10 49	19·7	110
	P—*n*	7	25 37	9 57	90·0	89	25 37	9 57	90·0	89
	P—*t*	7	30 12	9 38	232·4	61	30 12	9 38	231·8	61

7	P—q	7–8	27	20	10	50	20·0	109	27	20	10	51	20·2	108
	P—n	7	25	37	9	58	91·0	89	25	37	9	59	91·0	89
	P—t	7	30	12	9	38	230·5	63	30	12	9	39	229·9	64
8	P—q	7–8	27	17	10	52	19·9	105	27	17	10	52	20·0	104
	P—n	7	25	34	10	0	93·3	87	25	34	10	0	94·0	86
	P—t	7	30	9	9	41	229·2	66	30	9	9	41	228·7	67
9	P—q	7–8	27	14	10	53	19·7	102	27	13	10	54	19·6	101
	P—n	7	25	31	10	1	95·4	85	25	30	10	2	96·1	85
	P—t	7	30	6	9	42	228·1	69	30	5	9	43	227·8	70
10	P—q	7–8	27	9	10	55	18·8	98	27	7	10	55	18·7	96
	P—n	7	25	26	10	3	97·6	83	25	24	10	3	98·4	82
	P—t	7	30	1	9	44	227·8	73	29	59	9	44	227·7	74
11	P—q	7–8	27	2	10	57	17·8	93	27	0	10	57	17·2	92
	P—n	7	25	19	10	5	100·7	81	25	17	10	5	101·6	79
	P—t	7	29	54	9	46	227·2	78	29	52	9	46	227·3	80
12	P—q	7–8	26	54	10	58	16·1	88	26	51	10	59	15·3	87
	P—n	7	25	11	10	6	104·2	77	25	8	10	7	105·2	76
	P—t	7	29	46	9	47	227·1	84	29	43	9	48	227·3	86
13	P—q	7–8	26	44	11	0	13·6	83	26	40	11	1	12·5	82
	P—n	7	25	1	10	8	107·4	74	24	57	10	9	109·4	72
	P—t	7	29	35	9	49	227·3	90	29	31	9	50	227·6	92
14	P—q	7–8	26	33	11	2	10·3	78	26	29	11	3	9·1	76
	P—n	7	24	50	10	10	112·7	70	24	46	10	11	114·1	69
	P—t	7	29	24	9	51	227·8	97	29	20	9	52	228·2	99

Day. 1877.	Stars of Comparison.	Mag.	Hour Angle -4^h (Evening Observations). R.A. of Middle Point. h m s	Dec. of Middle Point. ° ′	Position Angle. °	Distance. ′	Hour Angle $+4^h$ (Morning Observations). R.A. of Middle Point. h m s	Dec. of Middle Point. ° ′	Position Angle. °	Distance. ′
Aug. 15	P—*q*	7–8	23 26 21	−11 4	6·3	73	23 26 16	−11 5	4·8	72
	P—*n*	7	24 38	10 12	117·9	66	25 33	10 13	119·7	65
	P—*s*	7–8	28 9	9 57	216·5	76	28 40	9 58	217·5	78
16	P—*q*	7–8	26 5	11 7	0·0	69	26 2	11 7	358·9	67
	P—*n*	7	24 22	10 15	124·5	62	24 19	10 15	127·0	62
	P—*s*	7–8	27 53	10 0	219·0	84	27 50	10 0	219·1	86
17	P—*q*	7–8	25 50	11 9	353·6	64	25 46	11 10	351·7	64
	P—*n*	7	24 7	10 17	132·7	59	24 3	10 18	134·8	58
	P—*s*	7–8	27 38	10 2	220·8	92	27 34	10 3	221·3	94
18	P—*q*	7–8	25 33	11 11	345·3	60	25 27	11 12	342·7	61
	P—*n*	7	23 50	10 19	142·2	57	23 45	10 20	144·9	56
	P—*s*	7–8	27 21	10 4	222·5	102	27 16	10 5	223·2	104
19	P—*m*	7	23 2	11 27	26·4	90	22 55	11 27	24·9	87
	P—*n*	7	23 32	10 22	152·1	55	23 25	10 22	156·1	56
	P—*r*	8	26 45	11 0	292·0	75	26 38	11 0	289·7	77
20	P—*m*	7	22 42	11 29	22·0	82	22 36	11 30	20·3	79
	P—*n*	7	23 12	10 24	163·3	56	23 6	10 25	166·8	58
	P—*r*	8	26 26	11 3	286·3	82	26 20	11 3	284·4	85
21	P—*m*	7	22 21	11 32	16·0	74	22 14	11 32	13·9	71
	P—*n*	7	22 51	10 27	174·3	59	22 44	10 27	177·7	61
	P—*r*	8	26 5	11 5	281·4	91	25 58	11 5	279·8	94

22	P—*m*	7	22	0	11	34	8·7	67	21	52	11	35	5·3	64
	P—*n*	7	22	30	10	29	183·9	64	22	22	10	30	187·5	67
	P—*q*	7–8	24	13	11	21	306·2	68	24	4	11	22	302·9	70
23	P—*m*	7	21	36	11	37	358·3	60	21	28	11	38	354·5	59
	P—*n*	7	22	6	10	32	193·2	71	21	58	10	33	195·9	74
	P—*q*	7–8	23	49	11	24	297·1	75	23	41	11	25	294·5	77
24	P—*n*	7	21	41	10	34	200·7	80	21	33	10	35	203·0	83
	P—*q*	7–8	23	24	11	26	291·9	84	23	16	11	27	288·8	87
	P—*l*	8	17	37	11	12	90·0	92	17	29	11	13	90·7	88
25	P—*n*	7	21	15	10	37	207·2	90	21	7	10	38	208·8	94
	P—*q*	7–8	22	58	11	29	284·8	94	22	50	11	30	283·1	98
	P—*l*	8	17	11	11	15	93·6	79	17	3	11	16	95·3	75
26	P—*n*	7	20	51	10	40	212·4	101	20	40	10	40	213·8	105
	P—*q*	7–8	22	34	11	32	280·4	106	22	23	11	32	278·9	110
	P—*l*	8	16	47	11	18	98·6	67	16	36	11	18	100·9	63
27	P—*n*	7	20	22	10	42	216·9	113	20	13	10	43	218·1	117
	P—*m*	7	19	52	11	47	307·1	66	19	43	11	48	303·6	69
	P—*l*	8	16	17	11	20	105·9	55	16	8	11	21	109·4	51
28	P—*i*	5–6	14	51	10	55	138·2	101	14	41	10	56	141·0	99
	P—*h*	7	14	11	11	58	59·9	100	14	1	11	59	59·0	95
	P—*m*	7	19	24	11	50	296·9	75	19	14	11	51	294·8	79
29	P—*i*	5–6	14	21	10	57	146·7	96	14	12	10	58	149·6	95
	P—*h*	7	13	40	12	0	57·9	85	13	31	12	1	56·8	80
	P—*m*	7	18	54	11	52	289·6	86	18	45	11	53	288·1	90

Day. 1877.	Star Comparison	Mag.	Hour Angle -4^h (Evening Observations). R.A. of Middle Point. h m s	Dec. of Middle Point. ° ′	Position Angle. °	Distance. ″	Hour Angle $+4^h$ (Morning Observations). R.A. of Middle Point. h m s	Dec. of Middle Point. ° ′	Position Angle. °	Distance. ″
Aug. 30	P—*i*	5–6	23 13 52	−11 0	156·1	94	23 13 42	−11 1	159·0	93
	P—*h*	7	13 12	12 3	55·0	70	13 2	12 4	53·5	66
	P—*m*	7	18 25	11 55	284·1	99	18 15	11 56	282·9	103
31	P—λ	8	15 23	11 37	239·8	42	15 13	11 38	241·8	47
	P—*f*	6–7	11 13	11 34	107·3	91	11 3	11 35	108·9	86
	P—*h*	7	12 42	12 5	50·5	55	12 32	6	47·9	51
Sept. 1	P—λ	8	14 52	11 40	243·1	58	14 42	11 41	244·4	63
	P—*f*	6–7	10 42	11 37	114·2	78	10 32	11 38	116·5	74
	P—*h*	7	12 11	12 8	42·4	41	12 1	12 9	37·6	37
2	P—λ	8	14 19	11 42	245·2	74	14 9	11 43	246·1	79
	P—*f*	6–7	10 10	11 39	123·8	67	10 0	11 40	127·0	63
	P—*g*	7–8	10 29	12 6	70·7	48	10 19	12 7	69·8	43
3	P—*h*	6–7	11 8	12 13	278·0	21	10 58	11 9	294·9	21
	P—*g*	7–8	9 58	12 8	68·6	33	9 48	12 9	68·7	28
	P—λ	8	13 48	11 45	247·0	89	13 38	11 46	247·1	95
4	P—*f*	6–7	9 6	11 44	152·2	52	8 56	11 45	157·9	51
	P—*h*	6–7	10 35	12 15	309·4	25	10 25	12 16	301·3	29
	P—*g*	7–8	9 26	12 11	64·5	15	9 16	12 12	58·0	10
5	P—*g*	7–8	8 54	12 13	336·6	3	8 43	12 14	282·8	7
6	*f*—*g*	{6–7 / 7–8}	8 36	11 48	349·7	54	8 36	11 48	349·7	54

	P—g	7–8		8	21	12	15	265·3	17		8	10	12	15	263·4	26
	P—f	6–7		8	1	11	48	188·0	55		7	50	11	49	193·1	57
7	P—f	6–7		7	29	11	50	202·1	63		7	18	11	51	206·1	66
	P—h	6–7		8	58	12	21	273·1	67		8	47	12	22	272·0	73
	P—e	8		3	49	12	24	84·1	84		3	38	12	24	84·5	79
8	P—f	6–7		6	56	11	52	212·5	74		6	45	11	53	215·4	77
	P—h	6–7		8	25	12	23	270·0	83		8	14	12	24	269·2	88
	P—e	8		3	16	12	26	88·7	68		3	5	12	27	88·7	62
9	P—f	6–7		6	23	11	54	220·0	86		6	12	11	54	222·1	90
	P—g	7–8		6	43	12	21	258·8	67		6	32	12	21	258·7	71
	P—e	8		2	43	12	28	88·6	52		2	32	12	28	88·8	47
10	P—d	8		1	27	11	48	145·2	102		1	16	11	48	148·0	100
	P—g	7–8		6	11	12	22	258·8	82		6	0	12	22	258·8	87
	P—e	8		2	12	12	29	93·2	36		2	1	12	29	95·5	31
11	P—g	7–8		5	39	12	24	258·8	97		5	28	12	24	258·8	106
	P—e	8		1	41	12	31	103·5	21		1	30	12	31	111·0	16
	P—d	7–8		0	56	11	50	153·8	97		0	45	11	50	156·8	96
12	P—g	7–8		5	8	12	25	258·8	113		4	57	12	25	258·8	118
	P—e	8		1	10	12	32	144·5	10		0	59	12	32	176·8	9
	P—d	7–8	23	0	25	11	51	162·9	94	23	0	14	11	51	166·1	94
13	P—μ	8	22	59	11	12	44	70·5	36	22	59	1	12	45	69·3	31
	P—e	8	23	0	39	12	33	222·9	13	23	0	29	12	34	232·2	18
	P—d	7–8	22	59	54	11	52	172·1	93	22	59	44	11	53	175·2	93

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Day. 1877.	Stars of Comparison.	Mag.	Hour Angle -4^h (Evening Observations). R.A. of Middle Point. h m s	Dec. of Middle Point. ° ′	Position Angle. °	Distance. ′	Hour Angle $+4^h$ (Morning Observations.) R.A. of Middle Point. h m s	Dec. of Middle Point. ° ′	Position Angle. °	Distance. ′
Sept. 14	P—μ	8	22 58 41	−12 45	63·8	21	22 58 31	−12 46	58·0	17
	P—e	8	23 0 9	12 34	242·4	27	59 59	12 35	245·7	31
	P—d	7–8	22 59 24	11 53	181·2	94	59 14	11 54	184·2	95
15	P—d	7–8	58 55	11 54	189·6	97	58 45	11 54	192·2	99
	P—c	6–7	55 45	13 13	51·1	99	55 35	13 13	49·7	94
	P—e	8	59 40	12 35	249·8	41	59 30	12 35	250·7	45
16	P—d	7–8	58 25	11 55	197·2	103	58 15	11 55	199·5	104
	P—c	6–7	55 16	13 14	46·2	87	55 6	13 14	44·1	84
	P—e	8	59 11	12 36	253·0	55	59 2	12 36	254·2	59
17	P—d	7–8	57 59	11 56	203·9	108	57 50	11 56	205·7	111
	P—c	6–7	54 49	13 15	39·8	77	54 40	13 15	37·2	74
	P—e	8	58 44	12 37	255·3	68	58 35	12 37	256·0	72
18	P—d	7–8	57 32	11 56	209·6	115	57 23	11 56	211·4	117
	P—c	6–7	54 22	13 15	32·2	68	54 13	13 15	28·8	66
	P—μ	8	56 49	12 48	276·1	36	56 40	12 48	275·2	40
19	P—c	6–7	53 57	13 15	23·0	62	53 49	13 16	19·5	60
	P—b	7–8	51 12	12 48	88·4	104	51 4	12 49	88·3	101
	P—e	8	57 52	12 37	258·2	93	57 44	12 38	258·7	97
20	P—c	6–7	53 32	13 16	11·9	58	53 25	13 16	8·3	58
	P—b	7–8	50 47	12 49	88·1	92	50 40	12 49	88·1	89
	P—e	8	57 27	12 38	259·5	105	57 20	12 38	259·9	108

21	P—c	6–7	53	9	13	16	0·0	57	53	2	13	16	357·1	57
	P—b	7–8	50	24	12	49	87·9	81	50	17	12	49	87·8	77
	P—μ	8	55	36	12	49	272·3	71	55	29	12	49	272·2	75
22	P—c	6–7	52	47	13	15	350·1	58	52	39	13	15	346·6	59
	P—b	7–8	50	2	12	48	87·6	70	49	54	12	48	87·4	67
	P—μ	8	55	14	12	49	272·3	82	55	6	12	49	272·3	85
23	P—c	6–7	52	26	13	15	340·8	61	52	19	13	15	337·9	63
	P—b	7–8	49	41	12	48	86·2	60	49	34	12	48	86·0	57
	P—μ	8	54	55	12	49	272·4	92	54	46	12	49	272·5	96
24	P—c	6–7	52	6	13	15	332·9	66	52	0	13	14	330·9	68
	P—b	7–8	49	21	12	48	84·4	51	49	15	12	47	84·0	48
	P—μ	8	54	33	12	48	272·7	102	54	27	12	47	272·8	105
25	P—c	6–7	51	48	13	14	327·2	71	51	42	13	14	325·5	73
	P—b	7–8	49	3	12	47	81·6	42	48	57	12	47	80·4	39
	P—μ	8	54	15	12	47	273·2	111	54	9	12	47	273·3	114
26	P—c	6–7	51	30	13	13	322·6	78	51	25	13	13	321·3	79
	P—b	7–8	48	45	12	46	76·3	33	48	40	12	46	75·3	31
	P—a	6–7	48	26	12	29	121·8	49	48	21	12	29	123·2	48
27	P—c	6–7	51	14	13	12	319·3	84	51	10	13	12	318·2	86
	P—b	7–8	48	29	12	45	68·4	27	48	25	12	45	66·4	25
	P—a	6–7	48	11	12	28	124·9	42	48	7	12	28	126·7	40
28	P—c	6–7	51	0	13	11	316·7	91	50	56	13	11	316·3	92
	P—b	7–8	48	15	12	44	56·3	22	48	11	12	44	51·1	21
	P—a	6–7	47	56	12	27	128·9	35	47	52	12	27	130·9	34

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Sept. 29	*a*—*b*	7-7	22 47 19	−12 33	344·9	35	22 47 19	−12 33	344·9	35
	P—*b*	7-8	48 3	12 43	40·5	18	47 59	12 42	33·6	18
	P—*a*	6-7	47 44	12 26	132·6	29	47 40	12 25	134·3	27
30	*a*—*b*	7 & 7-8	47 19	12 33	344·9	35	47 19	12 33	344·9	35
	P—*b*	7-8	47 51	12 41	20·3	18	47 48	12 41	14·6	19
	P—*a*	6-7	47 32	12 24	137·5	23	47 29	12 24	138·8	21
Oct. 1	P—*a*	6-7	47 22	12 23	141·7	17	47 19	12 22	143·1	16
	P—*b*	7-8	47 41	12 40	3·6	21	47 38	12 39	0·0	22
2	P—*a*	6-7	47 13	12 21	147·4	12	47 11	12 20	149·0	10
	P—*b*	7-8	47 32	12 38	353·1	24	47 30	12 37	351·1	25
3	P—*a*	6-7	47 6	12 19	154·2	7	47 4	12 18	158·2	5
	P—*b*	7-8	47 25	12 36	347·3	29	47 23	12 35	345·9	30
4	P—*a*	6-7	47 2	12 17	166·6	3	47 0	12 16	180·0	1
	P—*b*	7-8	22 47 21	−12 34	345·0	33	22 47 19	−12 33	344·3	34